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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/711,145	08/27/2004	Steven Shyng-Tsong T. Chen	FIS920040211US1	5144

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EXAMINER
GREEN, PHILLIP

ART UNIT	PAPER NUMBER
2823	

DATE MAILED: 12/28/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/711,145	CHEN ET AL.	
	Examiner	Art Unit	
	Phillip S. Green	2823	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *21 November 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-20* is/are pending in the application.

4a) Of the above claim(s) *17-20* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-16* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *08/27/2004*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

1. Applicant's election with traverse of Group II, Claims 1-16, drawn to a method of forming an interconnect structure in the reply filed on 11/21/2005 is acknowledged. The traversal is on the ground(s) that both Groups I and II are one and the same, and they do not fit the criteria for restriction. This is not found persuasive because as stated within the restriction requirement, "inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make other and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f))." In this application, the examiner restricted the product claims from the process claims on the grounds that "the product as claimed can be made by another and materially different process such as a process wherein device is made by depositing a dielectric layer and etching trenches therein, but the device could be made by selectively depositing the dielectric layer to have the trenches formed therein," and that, as a result, a restriction was necessary.

In addition to one way distinctiveness, an explanation was provided in the restriction requirement. Specifically, in addition to being distinct, the examiner indicated that restriction is proper because the product claims and the process claims "have acquired a separate status in the art."

The criteria of distinctness and burdensomeness have been met, as demonstrated hereinabove. Accordingly, the restriction requirement in this application is still deemed proper and is therefore made FINAL.

2. Claims 17-20 are withdrawn from further consideration pursuant to 37 CFR 1.142(b), as being drawn to a nonelected invention, there being no allowable generic or linking claim. Applicant timely traversed the restriction (election) requirement in the reply filed on 11/21/2005.

Information Disclosure Statement

3. The information disclosure statement (IDS) submitted on 8/27/2004 was filed after the mailing date of the invention on 8/27/2004. The submission is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being considered by the examiner.

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

5. Claims 1-3, 5, 7, 11 and 13-16 are rejected under 35 U.S.C. 102(e) as being anticipated by Hu et al. (US 6,660,627 B2).

Re claim 1, Hu discloses a method of forming an interconnect structure comprising the steps of:

depositing a dielectric layer **(38)**;

forming a hard mask over the dielectric material **(40)**;

etching trenches **(44)** in the dielectric material;

depositing a liner material **(46)** over the hard mask **(40)** and within the trenches **(50)**; and

overfilling the trenches **(44)** with a conductive material **(48)**;

characterized by:

performing a first chemical mechanical polishing process to remove conductive material **(48)** which is atop the liner **(46)**, thereby exposing the liner **(46)**; (Note: Fig. 2D)

removing that portion of the liner **(46)** which is atop the hard mask **(40)**; (Note: Fig. 2E)

removing a first portion of the hard mask **(42)** using a wet etch process, thereby leaving in place a second portion of the hard mask **(40)**; and (Note: Fig. 2F)

performing a touch-up polishing process to remove conductive material and liner material protruding from the trenches. (Note: Col. 3, Line 41- Col. 4, Line 60)

Re claim 2, pertaining to claim 1 above, Hu discloses the dielectric layer comprising a low-k material. (Note: Col 3, Lines 4-5)

Re claim 3, pertaining to claim 1 above, Hu discloses the dielectric layer comprising an ultra low-k material. (Note: Col 3, Lines 4-5)

Re claim 5, pertaining to claim 1 above, Hu discloses the conductive material comprising copper. (Note: Col 3, Lines 37-40)

Re claim 7, pertaining to claim 1 above, Hu discloses the portion of the liner, which is atop the hard mask is removed by a second chemical mechanical polishing process. (Note: Col 4, Lines 19-35)

Re claim 11, pertaining to claim 1 above, Hu discloses the second portion of the hard mask comprising a silicon carbide (SiC) material.

Re claim 13, pertaining to claim 1 above, Hu discloses the touch-up polishing process using an abrasive-free or low-abrasive polish to obtain a very high selectivity between the conductive material and the second portion of the hard mask. (Note: Col 4, Lines 36-59)

Re claim 14, Hu discloses the method of forming an interconnect structure comprising the steps of:

depositing a dielectric material **(38)**;

forming a hard mask over the dielectric material **(40)**;

etching trenches in the dielectric material **(44)**; and

overfilling the trenches with a conductive material **(44)**;

characterized by:

performing a first chemical mechanical polishing step;

then, performing a wet etch step; and

then, performing a second chemical mechanical polishing step. (Note: Col 3, Lines 4-5)

Re claim 15, pertaining to claim 14 above, Hu discloses at least a portion of the hard mask is substantially intact. (Note: Fig. 2F)

Re claim 16, pertaining to claim 14 above, Morrow discloses the portion of the hard mask, which is left substantially intact, comprises a silicon carbide SiC material. (Note: Fig 2F)

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

7. Claims 4, 8-10 and 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hu et al. (US 6,660,627 B2), as applied in Paragraph 5 above, and in view of Morrow (US 6,872,666 B2).

Re claim 4, as applied to claim 1 in Paragraph 5 above, Hu discloses all the claimed limitations including a silicon carbide or oxide hard mask.

However, Hu does not specifically disclose, wherein, the hard mask comprises: a layer of silicon carbide material atop the dielectric layer, and a layer of oxide atop the layer of silicon carbide.

Morrow discloses the method of making a damascene interconnect using a dual hard mask comprising a: a layer of silicon carbide material atop the dielectric layer (**103**), and a layer of oxide **(108)** atop the layer of silicon carbide **(109)**. (Note: Col 3, Lines 1-26)

Both Hu and Morrow teachings are directed to fabricating a interconnect forming a dual mask. Therefore, the teachings of Hu and Morrow are analogous.

Therefore, it would have been obvious to one having ordinary skill in the art at the time of applicant(s) claimed invention was made to provide the Hu reference with a dual hard mask of a layer of silicon carbide material atop the dielectric layer, and a layer of oxide atop the layer of silicon carbide as taught by Morrow in order to form an interconnect because the dual hard mask enables different portions of dielectric layer. (Note: Col 3, Line 4- Line7)

Re claim 8, as applied to claim 1 in Paragraph 5 above, Hu discloses all the claimed limitations including a silicon carbide or oxide hard mask.

However, Hu does not specifically disclose, wherein, the hard mask comprises: a layer of silicon carbide material atop the dielectric layer, and a layer of oxide atop the layer of silicon carbide.

Morrow discloses the method of making a damascene interconnect using a dual hard mask comprising a: a layer of silicon carbide material atop the dielectric layer (**103**), and a layer of oxide **(108)** atop the layer of silicon carbide **(109)**. (Note: Col 3, Lines 1-26)

Both Hu and Morrow teachings are directed to fabricating a interconnect forming a dual mask. Therefore, the teachings of Hu and Morrow are analogous.

Therefore, it would have been obvious to one having ordinary skill in the art at the time of applicant(s) claimed invention was made to provide the Hu reference with a dual hard mask of a layer of silicon carbide material atop the dielectric layer, and a layer

of oxide atop the layer of silicon carbide as taught by Morrow in order to form an interconnect because the dual hard mask enables different portions of dielectric layer. (Note: Col 3, Line 4- Line7)

Re claim 9, as applied to claim 8 in the paragraph above, Hu discloses ensuring that the oxide portion of the hard mask is thick enough such that the topographical variations after the first chemical mechanical polishing process and liner removal are entirely within the oxide portion of the hard mask. (Note: Fig. 2)

Re claim 10, as applied to claim 8 in the paragraph above, Hu discloses an oxide with a thickness smaller than 1000 Angstrom.

Re claim 12, as applied to claim 1 in Paragraph 5 above, Hu discloses all the claimed limitations including a silicon carbide or oxide hard mask.

However, Hu does not specifically disclose, wherein, the hard mask comprises: a layer of silicon carbide material atop the dielectric layer, and a layer of oxide atop the layer of silicon carbide.

Morrow discloses the method of making a damascene interconnect using a dual hard mask comprising a: a layer of silicon carbide material atop the dielectric layer (**103**), and a layer of oxide **(108)** atop the layer of silicon carbide **(109)**. (Note: Col 3, Lines 1-26)

Both Hu and Morrow teachings are directed to fabricating a interconnect forming a dual mask. Therefore, the teachings of Hu and Morrow are analogous.

Therefore, it would have been obvious to one having ordinary skill in the art at the time of applicant(s) claimed invention was made to provide the Hu reference with a

dual hard mask of a layer of silicon carbide material atop the dielectric layer, and a layer of oxide atop the layer of silicon carbide as taught by Morrow in order to form an interconnect because the dual hard mask enables different portions of dielectric layer. (Note: Col 3, Line 4- Line7)

8. Claim 16 is rejected under 35 U.S.C. 103(a) as being unpatentable over Hu et al. (US 6,660,627 B2), as applied in Paragraph 5 above, and in view of Allen et al. "Substrate Smoothing Using Gas Cluster Ion Beam Processing."

Re claim 6, as applied to claim 1 in Paragraph 5 above, Hu discloses all the claimed limitations.

However, Hu does not specifically disclose, wherein the portion of the liner which is atop the hard mask is removed by a reactive ion etch (RIE) or a Gas Cluster Ion Beam (GCIB) process.

Allen discloses the method of using a gas cluster ion beam for surface smoothing. (Note: Abstract)

Both Hu and Allen teachings are directed to the smoothing of a substrate with chemical metal polishing and gas cluster ion beam, respectively. Therefore, the teachings of Hu and Allen are analogous.

Therefore, it would have been obvious to one having ordinary skill in the art at the time of applicant(s) claimed invention was made to provide the Hu reference with the gas cluster ion beam processing as taught by Allen in order to obtain thin films with smooth, atomic layer control of the surface finish with the occurrence of sub-surface damage. (Note: Col 1, Lines 1-3)

Correspondence

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Phillip S. Green whose telephone number is (571) 272-7024. The examiner can normally be reached on Monday thru Thursday 8:30 am to 6:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Smith can be reached on (571) 272-1907. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

PG
12/16/2005

Brook Kebede

BROOK KEBEDE
PRIMARY EXAMINER